Model HI-4433

Broadband Isotropic Field Probe

User Manual

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HOLADAY EMF MEASUREMENT

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C	Added Probes	September, 1995
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Revision	Description	Date
K	Updated branding: Revised to meet Style Guide specifications; reformatted to half-size; PIB included with release	March, 2009

Table of Contents

Notes, Cautions, and Warnings vii

Introduction 9

ETS-Lindgren Product Information Bulletin 10

Maintenance 11

Maintenance Recommendations 11

Annual Calibration 11

Replacement and Optional Parts 12

Upgrade Policies 13

Service Procedures 13

Specifications 15

General Specifications 15

H-Field Probes 16

HI-4433-HCH 16

HI-4433-LFH 16

HI-4433-CH 17

E-Field Probe Specifications 17

HI-4433-STE 17

HI-4433-GRE 18

HI-4433-MSE 18

Practical Application and Use 19

System Theory 19

Automatic Zero 19

Probe Power Supply 20

Application Considerations 20

HI-4416 Hand Held Readout 21

HI-4413P Fiber Optic Interface 22

Operation 23

Xmit/Rcv 23

ARM/OFF 24

Charger 24

Assembling the Probe 26

Appendix A: Warranty 29

Appendix B: EC Declaration of Conformity 31

Appendix C: Series H-491198-36 Battery Charger for NiCd Batteries..... 33

Safety Precautions.....33

Introduction 33

Battery Life.....34

Charging a Battery.....34

Specifications.....36

Maintenance Recommendations 37

Appendix D: HI-4433 Operating Protocols 39

Notes, Cautions, and Warnings

	Note: Denotes helpful information intended to provide tips for better use of the product.
CAUTION	**Caution**: Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.
WARNING	**Warning**: Denotes a hazard. Failure to follow instructions could result in SEVERE personal injury and/or property damage. Included text gives proper procedures.

See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

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Introduction

The HI-4433 series comprises a family of battery-operated broadband radio frequency (RF) isotropic field probes designed for use in making RF exposure measurements in the vicinity of broadcast facilities and industrial RF sources. These probes use optical isolation to minimize field perturbation during measurements. Each probe in this series has characteristics that optimize its performance for a particular application. Model number differentiates individual probes for example HI-4433-XXX, where XXX defines the specific probe.

Each HI-4433 series probe assembly consists of a spherical casing containing the sensor mounted on one end of a shaft. The other end of the shaft is attached to an extrusion that houses the electronics. The sensor and electronics housing operate, and are calibrated, as a unit. Since the appearance and layout of the electronics housing are the same for all probes in this series, both the probe assembly and the housing are coded with identical serial numbers to prevent mismatch.

HI-4433 series probes measure the field strength in each of three axes. They perform a vector addition calculation on the readings and send the result to the readout via a fiber optic cable. Data from each axis can be viewed individually, or can be combined. The measurement capability and frequency response of HI-4433 series probes depend upon which model is selected. In addition, both magnetic and electric field probes are available.

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Warranty information
- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

Maintenance

CAUTION

Before performing any maintenance, follow the safety information in the ETS-Lindgren Product Information Bulletin included with your shipment.

Maintenance of the HI-4433 Broadband Isotropic Field Probe is limited to external components such as cables or connectors.

To prevent electrical shock, do not remove cover.

Warranty may be void if the housing is opened.

If you have any questions concerning maintenance, contact ETS-Lindgren Customer Service.

Maintenance Recommendations

Maintenance of the HI-4433 probe is limited to external components such as cables or connectors.

Annual Calibration

The HI-4433 probe assembly (sensor and electronics housing) requires an annual calibration check to verify that they are performing within specifications. See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

Replacement and Optional Parts

Following are the part numbers for ordering replacement or optional parts for the HI-4433 Broadband Isotropic Field Probe.

Replacement Parts	
Part Description	**Part Number**
Battery Pack, 3.6 VDC, Rechargeable	H-491038
Standard Fast Charger (115/230 Volt)	H-491198-36
Cable, Fiber Optic, Glass, 2 Meter	H-491106-xx (where “xx” = length”)
Probe Cover (2 required)	H-470286A
Handle Assembly	H-491001
HI-4433 User Manual	H-600056
Shipping Carton	H-390066

Optional Parts	
Part Description	**Part Number**
Tripod, Dielectric, HI-4433	H-491009
Fiber Optic/RS232 Interface	HI-4413P
ProbeView EMF Analysis Software	ProbeView II
Digital Remote Readout	HI-4416
Carrying Case	H-491083

Upgrade Policies

Periodically, probes are upgraded to enhance functionality. Contact ETS-Lindgren Customer Service for the upgrade status of your probe.

Service Procedures

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

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Specifications

General Specifications

Calibration Accuracy	• Overall +2/-3 dB* • At calibration points ±0.5 dB* *Absolute accuracy to NIST ± 1.0 dB
Isotropicity	± 0.5 dB
Linearity	±0.5 dB
Environmental	• Operating Temp. 10ºC to 40ºC (50º F to 104ºF) • Humidity 5% to 95%* *relative humidity, non-condensing
Fiber Optic Cable Connector	Standard FSMA
Battery	3.6 VDC, 14000mA-h rechargeable Nickel-Cadmium (NiCd), 20 hours of continuous operation
Battery Charger	115/230 VAC, approximately 1 hour
Size	• Length* 559mm (22.0 in.) • Probe Diameter 102mm (4.0 in.) • Weight* 0.57 kg (20 oz) *Including electronics housing
Probe Mount	¼ - 20 UNC tapped hole (internal thread) in base of probe

H-Field Probes

HI-4433-HCH

Ranges	0.1, 0.3, 1.0, 3.0 A/m full scale
Frequency Response	5.0 MHz to 300 MHz
	See General Specifications table for additional information.

HI-4433-LFH

Ranges	1.0, 3.0, 10.0, 30.0 A/m full scale
Frequency Response	0.3 MHz to 30.0 MHz
	See General Specifications table for additional information.

HI-4433-CH

Ranges	0.3, 1.0, 3.0, 10.0 A/m full scale
Frequency Response	5.0 MHz to 300 MHz
	See General Specifications table for additional information.

E-Field Probe Specifications

HI-4433-STE

Ranges	100, 300, 1000, 3000 V/m full scale
Frequency Response	0.5 MHz to 5.0 GHz
	See General Specifications table for additional information.

HI-4433-GRE

Ranges	10, 30, 100, 300 V/m full scale
Frequency Response	0.5 MHz to 5.0 GHz
	See General Specifications table for additional information.

HI-4433-MSE

Ranges	30, 100, 300, 1000 V/m full scale
Frequency Response	0.5 MHz to 5.0 GHz
	See General Specifications table for additional information.

Practical Application and Use

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren Product Information Bulletin included with your shipment.

System Theory

HI-4433 series Broadband RF Probes utilize a microprocessor for intelligent operation and control. Their self-contained power supply employs a 3.6 VDC NiCd battery, which provides up to 20 hours of continuous operation.

For each axis, the probe measures the radio frequency signal level and generates a linearized reading of this measurement. A vector addition is performed on these three readings: the resultant is transmitted to the readout over glass fiber optic cables.

Receiver commands to the probe consist of the following:

- Send reading
- Read battery voltage
- Zero
- Set sleep timer
- Switch range
- Read temperature
- Enable axis

Automatic Zero

This feature eliminates the need for internal zero adjustment and eliminates the temperature drift problems associated with other instrumentation. The automatic continuous zero also allows the operator to use the meter immediately upon power-up. Also, it is not necessary to place the meter in a zero field environment to check its zeroing.

In addition to the inputs from the three axes, HI-4433 series probes utilize a fourth input called the Autozero channel. This is a redundant channel identical to the three axis channels except that, instead of being driven by a dipole, it is terminated (in the probe head) by a carbon resistor. This resistor simulates the zero-bias impedance of the Schottky diode in series with the high resistance feed line; it is also subject to the same temperature variations as the feed lines of the other three channels.

Probe Power Supply

A sealed rechargeable 3.6 VDC NiCd battery, which drives both the analog and digital power supplies, powers HI-4433 series probes; separate power sources provide isolation between the analog and digital circuitry. With the probe switch in the ARM position, battery voltage is applied to the power switch, which routes this voltage to the power control and the switching power supply, enabling the microprocessor. This power supply does not shut off automatically. Always turn the power supply off when the probe is not in use.

Application Considerations

Resolution Limitations

Limitations in probe resolution may result in a non-zero reading when the receiver is zeroed. If this occurs, it does not necessarily mean either that there is a problem with the receiver or that your readings are inaccurate. Receiver linearity is specified as + 0.5 dB full scale: in addition, the variance of the A/D converter is + 2 least significant bits. When using the most sensitive range on a given probe, these specifications create the possibility that, under zero field conditions, the receiver may display a non-zero value.

Probe Support Structures

It is very important to keep conductive objects away from the HI-4433. Any such objects in the proximity of the probe may distort the near field and compromise measurement accuracy. If your application requires measurements from a fixed position, always mount the probe on a non-metallic platform, using non-metallic screws.

Optional Probe Interface/Readout

The probe provides data to the readout via either a short form or long form output word. Commands to the probe use these same word forms. See Appendix B for details on the format for both out put words.

HI-4416 Hand Held Readout

The HI-4416 provides a digital display and data logging capabilities as well as optical isolation when a hand-held readout is desired.

HI-4413P Fiber Optic Interface

For limited, specialized applications, you may use any computer with an RS232 serial port to communicate directly with the HI-4433 series probes via ETS-Lindgren's optional HI-4413P Fiber Optic/RS232 Interface.

Operation

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren Product Information Bulletin included with your shipment.

A switch, two fiber optic connectors and a battery charger connector are mounted on the HI-4433 electronics housings.

Xmit/Rcv

The fiber optic cable assembly from the receiver is attached to the probe via two connectors. The cables are color-coded: white for XMIT, yellow for RCV. Identically colored dots are located on the electronics housing adjacent to these connectors. Ensure that each cable is attached to the proper probe connector.

When the fiber optic cables are not attached, always cover the probe connectors with the protective plastic covers supplied with the unit, or with similar material. This prevents dirt or other contaminants from entering the connector and causing communication problems.

ARM/OFF

The ARM/OFF switch activates and deactivates the probe. In the ARM position, the probe is powered by its internal 3.6 VDC NiCd battery: in the OFF position, the probe is inactive. To prolong battery life, set the ARM/OFF switch to OFF at the end of a test sequence or when the probe is not in use.

Charger

Each HI-4433 probe contains a rechargeable nickel-cadmium (NiCd) battery. A fully-charged battery (nominal output voltage of 3.6 VDC) provides up to 17 hours of continuous operation.

ETS-Lindgren charges the internal NiCd battery of the HI-4433 at the factory in order to calibrate the probe prior to shipment. While every effort is made to ensure that your probe arrives ready to use, we cannot guarantee that this will be the case. Always check the condition of the battery prior to making any measurements.

A standard fast charger is supplied with the HI-4433. When charging is complete, the fast charger acts as a trickle charger.

Charging Procedure

Begin by plugging the charger into a suitable AC source. Next, set the probe switch to OFF. Insert the plug on the charger cable into the probe's CHARGER jack.

The battery is now charging. Charging may take approximately one hour, depending on how deeply the batteries are discharged. When charging is complete, the charger will automatically begin a trickle charge and will continue to do so until the probe is disconnected.

Tips

NiCd batteries have several characteristics that can affect both their performance and operating life. The following tips advise you how to take advantage of these characteristics to get the most out of your probe’s battery.

- Although NiCd batteries are rated for operation in temperatures from -20ºC to +65ºC (-4ºF to +140ºF), operating the probe in extreme temperatures will reduce operating time significantly. The optimum operating temperature range for these batteries is +20ºC to +30ºC (+68ºF to +86ºF).

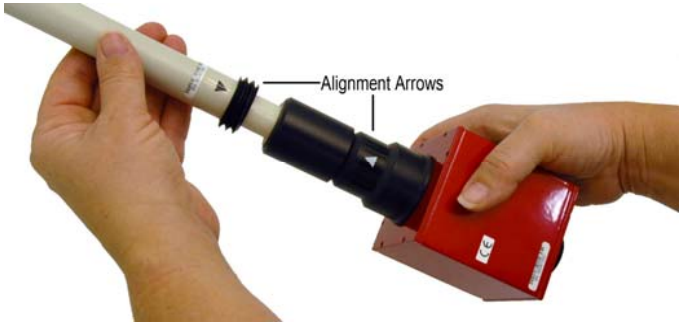
- The battery in the HI-4433 probe does not require periodic deep discharges to reverse the capacity depleting memory effect caused by repeated shallow discharges; however, undercharging can reduce battery capacity. Therefore, after the charging procedure is complete, be sure that the battery is fully charged before resuming field operation.

- If the battery exhibits low terminal voltage during charging, or if it appears unable to acquire or maintain an appreciable charge, individual cells in the battery may be shorted or damaged. If, for any reason, your battery needs replacement, contact ETS-Lindgren Customer Service for assistance.

Assembling the Probe

Each HI-4433 series probe assembly consists of a spherical casing containing the senor mounted on one end of a shaft and an extrusion that houses the electronics. The sensor and electronics housing operate, and are calibrated, as a unit. Since the appearance and layout of the electronics housing are the same for all probes in this series, both the probe assembly and the housing are coded with identical serial numbers to prevent mismatch.

To begin assembly, locate the probe and the corresponding probe housing.



Position the alignment arrows on the probe and housing so they are lined up, and then gently press the probe into the housing.

Pull the collar on the housing up to the threads on the probe and twist to begin tightening.

Turn the collar until the threads on the probe are covered. Be careful not to over-tighten.

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Appendix A: Warranty

See the *Product Information Bulletin* included with your shipment for the complete ETS-Lindgren warranty for your HI-4433 Broadband Isotropic Field Probe.

DURATION OF WARRANTIES FOR HI-4433 BROADBAND ISOTROPIC FIELD PROBE

All product warranties, except the warranty of title, and all remedies for warranty failures are limited to one year.

Product Warranted	Duration of Warranty Period
HI-4433-xxx	1 Year

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Appendix B: EC Declaration of Conformity

ETS-LINDGREN™
An ESCO Technologies Company

CE 05

We, ETS-Lindgren, L.P., 1301 Arrow Point Drive, Cedar Park, TX, 78613, USA, declare under sole responsibility that the:

Model/Part Number: HI-4433 Series

Model/Part Name: HI-4433 Series of Probes

Date of Declaration: 01 January, 1997

Affirmation Date: 21 April, 2009

to which this declaration relates, meets the requirements and is in conformity with the relevant EC Directives listed below using the relevant section(s) of the following EC harmonized standards and other normative documents;

Applicable Directive(s):

Electomagnetic Compatibility Directive (EMC), 89/336/EEC and its amending directives

Applicable harmonized standard(s) and/or normative document(s):

CISPR 11 (EN 55011): Electromagnetic emissions requirements for Industrial, Scientific and Medical (ISM) Equipment (Class B)

EN 50082-1:1992 Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry

EN 55011: Electromagnetic emissions requirements for Industrial, Scientific and Medical (ISM) Equipment

Authorized Signatories:

ETS-Lindgren L.P.
Bryan Sayler, General Manager

ETS-Lindgren L.P.
James C. Psencik, Vice President of Engineering

The authorizing signatures on this Declaration of Conformity document authorizes ETS-Lindgren, L.P. to affix the CE mark to the indicated product. CE marks placed on these products will be distinct and visible. Other marks or inscriptions liable to be mistaken with the CE mark will not be affixed to these products.

ETS-Lindgren, L.P. has ensured that technical documentation shall remain available on premises for inspection and validation purposes for a period ending at least 10 years after the last product has been manufactured.

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Appendix C: Series H-491198-36 Battery Charger for NiCd Batteries

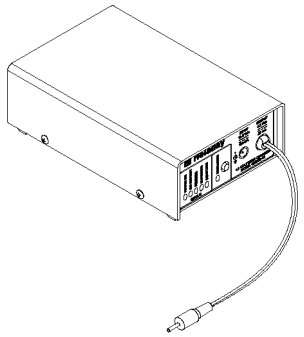
The HI-4422 Field Probe contains a Nickel Cadmium (NiCd) battery, and uses the Series H-491198-36 Battery Charger.

SAFETY PRECAUTIONS

CAUTION

Before operating the Series H-491198-36 Battery Charger, see General Safety Considerations on page *Error! Bookmark not defined.**.***

INTRODUCTION



The H-491198-36 Nickel-Cadmium (NiCd) Battery Charger is a dual power source battery charger. It charges 3.6 volt 1400 mAH NiCd batteries and is powered by 120-240 VAC line power or 12.5 VDC. The H-491198-36 Battery Charger uses a -(dV)/(dT) negative delta V technique to determine when the battery is fully charged, which is typically one hour. With this technique, the charge state of the battery has no effect other than shortening the charge time.

Housed in a rugged enclosure, power enters the battery charger through a power entry module, which contains the fuses, or an optional cigarette lighter plug adapter. The front face of the battery charger displays LEDs that provide the operating status. The battery charger connects to the device being charged through a short cord terminated with a power jack.

An integrated circuit within the battery charger monitors the battery voltage and controls the charging functions according to the charge state of the battery.

BATTERY LIFE

A fully-charged battery (nominal output voltage of 3.6 VDC) provides up to 20 hours of operation. When the battery has discharged to 3.3 VDC, the Field Probe is still operational, but the battery needs charging. When the voltage drops below 3.18 VDC, measurement accuracy will be compromised by further operation.

Follow these recommendations to ensure maximum battery life and optimum testing performance:

- Operate the Field Probe only within the optimum operating temperature range of +20°C to +30°C (+68°F to +86°F). Although NiCd batteries are rated for operation in temperatures from -20°C to +65°C (-4°F to +140°F), operating the Field Probe at temperature extremes reduces the operating time of the batteries.
- Make sure the battery is fully charged before resuming operation. The battery does not require periodic deep discharges to reverse the effect caused by repeated shallow discharges, but undercharging can reduce battery capacity.

If the battery exhibits low terminal voltages during charging, or if it appears unable to acquire or maintain a charge, individual cells in the battery may be shorted or damaged. If your battery needs replacement for any reason, contact ETS-Lindgren Customer Service.

CHARGING A BATTERY

1. Make sure the power switch on the Field Probe is set to the **OFF** position or the battery will not charge.
2. Connect the battery charger to the proper power source, and then connect the charger to the charger jack on the Field Probe.

Charging takes approximately one hour, depending on the degree of battery discharge. When charging is complete, the battery charger automatically enters into a trickle charge, and continues until the Field Probe is disconnected.

CAUTION **Never attempt to recharge a non-rechargeable battery.**

CHARGING INDICATORS

The following LEDs are located on the front of the battery charger:

- **POWER ON** (green)—Indicates the battery charger is connected to the AC power source.
- **NO BATTERY** (amber)—Indicates the battery charger does not detect a battery.
- **PENDING** (amber)—Indicates the battery charger detects a battery.

  Before fast charging can begin, the battery voltage must fall within predetermined acceptable limits. A pulse-trickle charge is provided to bring a depleted battery to a valid charge prior to fast charge.

- **CHARGING** (amber)—Indicates the voltage pre-qualification condition has been met, and fast charge has started.
- **COMPLETE** (green)—Indicates a fast charging peak voltage is detected. The Field Probe can remain connected to the battery charger indefinitely while in this maintenance mode.

BATTERY CHARGER SPECIFICATIONS

The H-491198-36 charger may be powered by standard line voltage (110 - 240 Vac, 50 - 60 Hz) or by an optional automobile cigarette lighter plug (12.5 Vdc).

Power	
Main:	IEC filtered AC power input module 110-240 VAC, 500 mA max, 50-100 Hz
Alternate:	Automobile cigarette lighter to 2 mm power plug adapter cord, 12.5 Vdc, 100 mA
Fuses:	250 volt, 1.0 Amp, Type T (5 mm x 20 mm)
Output	
Open Circuit Voltage:	15 Vdc
Fast Charge Pending Current:	60 mA
Fast Charge Current:	1400 mA
Pulsed Trickle Charge Current:	50 mA
Output Voltage (During Fast Charge):	3 - 6 Vdc
NiMH Battery:	• 3.6 volt 3 cell NiCd Battery, 1400 mAH (rapid charge cells, 1.2 volts/cell) • ETS-Lindgren Part #491038

Environmental	
Operating Temperature:	10^{o}C to 40^{o}C 50^{o}F to 104^{o}F
Humidity:	5% to 95% relative humidity, non-condensing

MAINTENANCE RECOMMENDATIONS

- Operate the battery charger with care.
- There are no user serviceable parts inside the battery charger. Opening the battery charger housing may void your warranty.

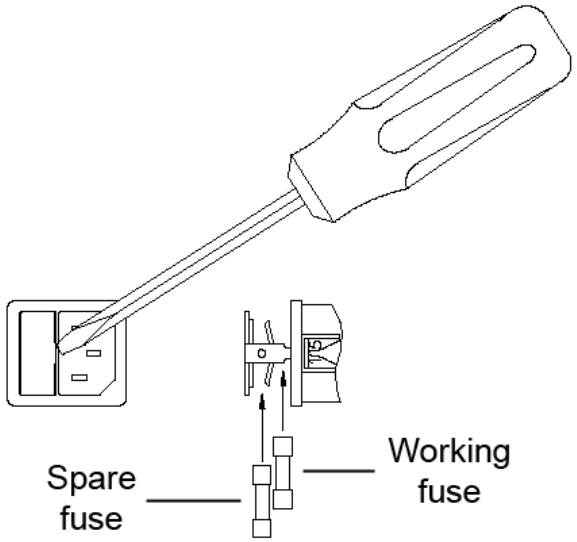
REPLACING THE FUSE

CAUTION **Disconnect the battery charger from power before replacing a fuse.**

If the battery charger fails to operate, check for a blown fuse inside the power entry module. A blown fuse must be replaced with the same value and type of fuse, or an unsafe condition may result. Use only 250 Volt, 1.0 Amp, Type T (5 mm x 20 mm) fuses.

To replace a fuse:

3. Two fuses are located in the fuse drawer in the power input module. Use a screwdriver to open the drawer.
4. The fuse towards the outside of the drawer is the spare. Remove the spare fuse from the module.



5. Replace the blown fuse with the spare fuse.
6. Slide the fuse drawer back into the module. Make sure that the drawer snaps securely into its locked position.

Appendix D: HI-4433 Operating Protocols

The following information assumes that the optional HI-4413P Fiber Optic/RS232 Interface was purchased and is capable of communicating directly with an HI-4433 probe via computer. No system readout is required when using this configuration.

COMMUNICATION PROTOCOL

Data Type:	RS-232 Serial
Data Mode:	Asynchronous
Word Length:	7 bit
Parity:	Odd
Stop Bits:	1
Data Rate:	9,600 baud

INFORMATION TRANSFER PROTOCOL

The HI-4433 series probes only respond to commands from another device; they transmit no data without first receiving instructions to do so.

COMMAND STRUCTURE

Probe Command	Description	Probe Response
Axxx	Axis enable/disable. • *x*=E (enable) or D (disable) • *xxx* order=X axis, Y axis, Z axis	
B	Read battery voltage.	*Bxx.xx*, • *xx.xx*=battery voltage

Probe Command	Description	Probe Response
Dx	Read probe data. • *x*=1, enables short form output • *x*=2, enables long form output	For **D1** command: *Dxx.xxuuu*, the short form output • *xx.xx*=the reading, and the position of the decimal point depends upon the range setting of the Field Probe • *uuu*=units • _V_ = V/m, mW2 = mW/cm², _V2 = [V/m]² (underscore indicates a space) For **D2** command: *Dxx.xxuuurrrobaaa*, the long for output • *xx.xx*=the reading, as described for D1 • *uuu*=units, as described for D1 • *rrr*=recorder out value, a three-digit ASCII number from 0 to 255 • *o*=over range indicator: *N*=ok, *O*=over range • *b*=battery status: *N*=safe operating level, *W*=warning level, *F*=fail level • *aaa*=axis enable: E=enabled, D=disabled, axis order=X, Y, Z

Probe Command	Description	Probe Response
Rx	Set range. • *x*=1, 2, 3, 4, or N (next range)	*Rx*, where *x* is the range • *x*=returns the range currently in use • *x*=1, 2, 3, 4 enables the selected range *x*=N sets the Field Probe to the next higher range
Tx	Read temperature. • *x*=C or F	For **TF** command: *Txxx* • *xxx*=temperature in degrees in Fahrenheit For **TC** command: *Txxx* • xxx=temperature in degrees in Centigrade
Ux	Set unit type. • *x*=1, 2, 3, or N (next unit) • 1=V/m • 2=mW/cm² • 3=[V/m]²	
Z	Zero	
Null	Send the ASCII null character.	This is a special command that can be used as the initial command to the Field Probe after it is turned on. The probe responds with *N*.

PROBE ERROR OUTPUT

If an error occurs, the probe will respond with one of the following strings. These strings begin with a colon and end with a carriage return.

E1	Communication error (for example, overflow)
E2	Buffer full error; too many characters contained between the start character and carriage return sequence
E3	Received command is invalid
E4	Received parameter is invalid
E5	Hardware error (for example, EEPROM failure)
E6	Parity error